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BY:

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Date:

November 18, 2005

MAIL STOP APPEAL BRIEF

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:
Yoshiaki Tanaka

Conf. No.: 7843

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Group Art Unit: 2835

Appln. No.: 10/656,580

:
Examiner: Anatoly Vortman

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:
Attorney Docket No.: 10844-33US
:(203061(C-3))

Title: Alloy Type Thermal Fuse and Material for a Thermal Fuse Element

**ON APPEAL FROM THE PRIMARY EXAMINER TO THE BOARD OF PATENT
APPEALS AND INTERFERENCES**

APPELLANT'S BRIEF UNDER 37 C.F.R. 41.37

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I. REAL PARTY IN INTEREST

This application is assigned to Uchihashi Estec Co., Ltd. of Osaki-shi, Japan, by an Assignment recorded on September 4, 2003, at Reel No. 014476, Frame 0667. Accordingly, Uchihashi Estec Co., Ltd is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

Appellant, his Assignee and their legal representatives are unaware of the existence of any related appeals and/or interferences that will directly affect, be directly affected by, or have a bearing on the decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1-58 are pending in the instant application on appeal.

Claims 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, and 58 are withdrawn from consideration as non-elected species.

Claims 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47 and 49 contain allowable subject matter and are objected to for depending on rejected claims.

Claims 1, 3, 5, 51, 53, 55 and 57 stand finally rejected as discussed below and are the subject of the instant appeal.

The complete text of claims 1, 3, 5, 51, 53, 55 and 57, as pending, is attached hereto as Appendix A.

IV. STATUS OF AMENDMENTS

No amendments have been filed in this application.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The claimed invention relates to Bi-In-Sn alloy type thermal fuses and materials for Bi-In-Sn thermal fuse elements (see, Appellant's Specification, ("Spec.") ¶ [0001]). The materials contain ternary alloy compositions of more than 55 to 74% In, more than 25% to less than 44% Sn, and 1 % to less than 20% Bi. Alloy type thermal fuses and fuse elements having the claimed elemental compositions have narrow operating temperature ranges and excellent overload and dielectric breakdown characteristics (Spec., ¶ [0010]). Alloy type thermal fuses according to the

invention may have the fuse element connected between lead conductors and optionally sandwiched between insulating films. In one embodiment, at least a portion of each lead conductor bonded to the fuse element is covered with a Sn or Ag film (Spec., ¶ [0016]).

In fuse elements having alloy compositions with a solid-liquid coexisting region (between the solidus and liquidus temperatures), there is a possibility that the fuse element will be fused off at an uncertain temperature in this region. A wide coexistence region thus results in a wide operating temperature range of the fuse. Conventionally, in order to reduce this dispersion of operating temperature, an alloy having a narrow solid-liquid coexistence region, and ideally a eutectic composition, is utilized so that the fuse element fuses off at approximately the liquidus temperature (which is equal to the solidus temperature in a eutectic composition) (Spec., ¶ [0003]).

A variety of ternary Sn-In-Bi alloys are known. As shown in the liquid phase surface Diagram 2 in attached Appendix B (previously filed with the Request for Reconsideration dated May 17, 2005), these alloys have a binary eutectic point at 52In-48Sn (point E1) and a ternary eutectic point (point E2) at 21Sn-48In-31Bi. The binary eutectic curve which elongates from the binary eutectic point toward the ternary eutectic point passes through a region having 24-47% Sn, 50-47% In, and 0-28% Bi (Spec., ¶ [0005]). However, alloy compositions in regions separated from the binary eutectic curve have wider solid-liquid coexistence regions, which may possibly widen an indefinite region of temperatures at which the fuse element fuses off and also increase the dispersion of the operating temperature of the thermal fuse. Accordingly, this region has not traditionally been investigated for suppressing the dispersion of operating temperature range by narrowing the solid-liquid coexistence region (Spec., ¶ [0007]).

However, by studying a variety of Bi-Sn-In alloys having different compositions and measuring the DSC (differential scanning calorimetry) profiles thereof, Appellant has surprisingly found that when an alloy composition in a specific region which is separated from the binary eutectic curve is used as a fuse element, the resulting fuse element can be concentrically fused off in the vicinity of the maximum endothermic peak, and excellent overload and dielectric breakdown characteristics are thus obtained. Appellant has thus discovered a specific ternary In-Sn-Bi alloy composition, usable for a fuse element, which is

suitable for environmental conservation and which provides excellent overload and dielectric breakdown characteristics and a narrow operating temperature range (Spec., ¶ [0026]).

The alloy composition in this region, which is separated from the binary eutectic curve, has a wide liquid coexistence region (as wide as 16°C) and a single maximum endothermic peak. Accordingly, the dispersion of the operating temperature of the alloy thermal fuse may be controlled. Moreover, in the alloy composition, the total amount of In and Sn, which have a relatively smaller surface tension, is larger than the amount of Bi, which has a larger surface tension. Therefore, the wettability of the solid-liquid coexisting at the maximum endothermic peak is sufficiently improved even before the completion of liquidification, so that spheroid diversion of the thermal fuse element can be performed in the vicinity of the maximum endothermic peak. Consequently, the dispersion of the operating temperature of the thermal fuse can be reduced (and set to be within a range of $\pm 5^{\circ}\text{C}$). The holding temperature of such thermal fuses (20 °C less than the operating temperature) may be less than or equal to the solidus temperature, which is desirable. Further, due to the relatively large percentages of In and Sn in the alloys, fuse elements having sufficient ductility to draw into thin wires, such as 200 to 300 $\mu\text{m}\phi$, can be achieved (Spec., ¶ [0026]).

Finally, by including a larger total concentration of In and Sn than Bi, the fuse element is divided in a wide solid-liquid coexisting state even during energizing and temperature rise, and the generation of an arc immediately after an operation may be satisfactorily suppressed. Due to the synergistic effects of arc suppression and reduced surface tension, physical destruction of the fuse is prevented, even in an overload test. Therefore, using the inventive fuses, insulation resistance after an operation can be maintained at a high level and excellent dielectric breakdown characteristics can be assured (Spec., ¶ [0026]).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 3, 5, 51, 53, 55 and 57 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Applicant's Admitted Prior Art (AAPA), and particularly over JP 2001-266724 ("JP '724").

VII. ARGUMENT

A. The Examiner's Position

In the Office Action mailed June 17, 2005 (hereinafter referred to as “final Office Action”), the Examiner maintains the rejection of claims 1, 3, 5, 51, 53, 55 and 57 as being unpatentable over AAPA, and particularly over JP ‘724, for the same reasons set forth in the Office Action mailed February 17, 2005, and makes the rejection final.

In the final Office Action, the Examiner argues that regarding claims 1 and 3, Appellant has disclosed in the “Description of the Prior Art” section of the application (p. 2 – 7), that fuses having fuse elements of ternary In-Sn-Bi alloys were known in the fuse art at the time the invention was made. Specifically, the Examiner argues that Appellant has pointed to JP ‘724 and stated that a fuse element which has an alloy composition of 42 to 53% In, 40 to 46% Sn, and 7 to 12% Bi was known in the fuse art. The Examiner argues that the claimed ranges in claim 1 are overlapping or close to the AAPA ranges.

Thus, the Examiner concludes that it would have been obvious to one having ordinary skill in the fuse art at the time of the invention to select ranges for ternary In-Sn-Bi alloys as claimed in claim 1, since a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art. The Examiner cites *In re Geisler* (116 F.3d 1465, 1469, 43 USPQ 2d 1362, 1365 (Fed. Cir. 1997)); *In re Woodruff* (919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936-7 (CCPA 1976)); and *In re Malagari* (499 F.2d 1297, 1303, 182 USPQ 549, 553 (CCPA 1974)). The Examiner further argues, citing *Titanium Metals Corp. v. Banner* (778 F.2d 775, 783, 227 USPQ 773, 779 (Fed. Cir. 1985)) that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition do not overlap but are close enough that one skilled in the art would have expected them to have the same properties.

The Examiner further contends that Appellant has not shown why it would not have been obvious to one versed in the art to adjust the AAPA ranges to arrive at the claimed ranges. The Examiner takes the position that all it takes to arrive at the claimed ranges is a routine experimentation with the AAPA alloy, and that the artisan in the relevant art at the time of the invention would have arrived at the claimed ranges in the course of routine experimentation,

since determination of optimum or workable ranges might be characterized as routine experimentation (citing *In re Antoine* 559 F.2d 618, 195 USPQ 6 (CCPA 1977)) and involves only routine skill in the art (citing *In re Boesch* 617 F.2d 272, 205 USPQ 215 (CCPA 1980)). Thus, the Examiner concludes that while routinely experimenting with the AAPA alloy at the time of the invention, one versed in the relevant art would have noticed positive changes in physical properties of the resulting alloy, and would have arrived at the claimed ranges in order to enhance breaking characteristics of the fuse.

Regarding claim 5, the Examiner argues that the fuse element inherently contains inevitable impurities.

Regarding claims 51, 53, 55 and 57, the Examiner argues that JP '724 teaches that fuse element (2) is connected between a pair of lead connectors (1) and sandwiched between insulating films (3), referring to Figs. 1 and 2 in JP '724.

B. Claims 55 and 57 Are Not Properly Rejected Because They Depend From Allowable Claims

Claims 55 and 57 depend from claims 7 and 9, respectively. Claims 7 and 9 are allowable but objected to. Claims depending on from allowable claims are not rejectable over the prior art. Therefore, it is believed that claims 55 and 57 were inadvertently rejected. Reversal of the rejection with respect to these claims is requested.

C. The Alloy Type Thermal Fuses and Materials for Thermal Fuse Elements of Rejected Claims 1, 3, 5, 51 and 53 are NOT obvious over AAPA

The rejected claims on appeal, as reproduced in Appendix A, are directed to alloy type thermal fuses and materials for thermal fuse elements containing ternary alloys having greater than 55% to 75% In, greater than 25% to less than 44% Sn, and 1% to less than 20% Bi.

1. The Prior Art and Claimed Compositions Do Not Overlap

In the final Office Action, the Examiner states that “the claimed ranges as recited in claim 1 are overlapping or close to the aforementioned AAPA ranges”. Although the ranges *per se* of two of the three elemental components (Sn and Bi) indeed overlap, the overall alloy

compositions do not overlap, as demonstrated in the liquidus projection Diagram 1 in Appendix B.

A liquidus projection diagram is a graphical representation of the elemental composition of a ternary alloy which portrays the concentrations of all three components at one time. Since the concentrations of all three components are critical, it is easier and more accurate to compare the liquidus projection diagrams than the numerical ranges individually. Thus, a liquidus projection diagram (which graphically represents the claimed composition) is a proper way to demonstrate that the claimed and prior art compositions as a whole do not overlap.

In a ternary alloy, the concentrations of all of the components are critical. In this case, the concentration of the third elemental component (In), which does not overlap in numerical range with that of the AAPA, results in an overall composition which does not overlap with the presently claimed alloy. Thus, since the overall compositions themselves do not overlap, the claimed and prior art alloys would not have been expected to have the same properties.

2. Cases Relied Upon By the Examiner Relate Only to One Overlapping Range

The Examiner argues, citing *In re Geisler*, *In re Woodruff* and *In re Malagari*, that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art. Appellant submits that these cases are not relevant to the rejection of the present claims, since they relate to overlapping ranges of only one property, and not to ternary alloys in which the concentrations of all three components and the overall compositions are critical.

For example, in *Woodruff*, Applicant's invention involved a specific gaseous atmosphere for maintaining leafy and head vegetables, which included a CO concentration of "more than 5%". The prior art cited by the Examiner, directed to a similar gaseous atmosphere, contained "about 1 to 5%" CO. The Court held that the claimed and prior art ranges were "roughly contiguous" and that the disclosure of "about 5%" allowed for concentrations slightly above 5%, including the "more than 5% of Applicants". The Court concluded that *Woodruff* had not shown that the particular range was critical by showing that the claimed range achieved unexpected results relative to the prior art range.

In *Malagari*, Applicants' invention was directed to a method for producing silicon steel by a method which was acknowledged to differ from the prior art only in the amount of carbon in the starting material, which was claimed to be "between 0.03 and 0.07% carbon". The prior art recited ranges of "0.02 to 0.03%" carbon. The Court affirmed the decision that the claims were unpatentable over the prior art, because the claimed range was touching the typical preferred range of the reference and because Applicants did not rebut the *prima facie* case (1) by establishing the existence of unexpected properties in the claimed range or (2) by showing that the art taught away from the claimed range, nor establish criticality of the lower limit of the claimed invention.

Finally, in *Geisler*, which related to a protective layer having a thickness of 50 to 100 Angstroms, the Court held that the claimed material was unpatentable over a prior art material having a thickness of 100 to 600 Angstroms, preferably 200 to 300 Angstroms. The Court found that even though the prior art reference taught that the layer should be not less than about 100 Angstroms, it was also taught that thinner layers could be used as well. It was found that the Applicant had not shown that the claimed protective layer exhibited unexpected properties in the claimed range, that is, a showing that the claimed range was critical. Further, the Court held that the prior art suggested that there were benefits to keeping the protective layer as thin as possible, and thus would provide the motivation for one to focus on thickness levels at the bottom of the "suitable" range and to explore thickness levels below that range. The Court found that a statement in the prior art that "the thickness of the protective layer should not be less than about 100 Å" fell far short of a teaching that would discourage one of skill in the art from fabricating a protective layer of 100 Å or less.

All of these cited cases relate to an overlapping or contiguous range of one property, such as layer thickness, percentage of CO, or amount of carbon. In contrast, as noted above, while the numerical concentrations of two of the elemental components of the claimed ternary alloy indeed overlap with prior art ranges, it is not the numerical concentrations of the individual components of an alloy which are critical, but rather the overall alloy compositions. Therefore, since the cases cited by the Examiner do not relate to situations with several interdependent properties (here, concentrations of alloy components), they are not relevant to the analysis of patentability

of the claimed materials for thermal fuse elements containing specific ternary alloy compositions.

3. AAPA and JP ‘724 Teach Away from the Claimed Invention

In re Malagari holds that a *prima facie* case based on overlapping or contiguous ranges may be overcome by (1) establishing the existence of unexpected properties in the claimed range; or (2) showing that the art teaches away from the claimed invention.

As required by *Malagari*, Appellant has indeed shown that the prior art teaches away from making the proposed modification which would result in the claimed invention. In order to arrive at the claimed In concentration from that recited in JP ‘724, one skilled in the art, if experimenting with the JP ‘724 alloy, would have had to increase the concentration of In from the JP ‘724 range of 42-53 % to the claimed range of greater than 55% to 74 %. This increase would have necessitated a reduction in the concentration of at least one of the other elements, such as to 5% Bi, 40% Sn or to 7% Bi, 38% Sn (below the recited ranges of Bi and Sn, respectively).

However, JP ‘724 teaches away from reducing the Bi concentration to below 7% (translation of JP ‘724 ¶ [0013]) by explaining that when the concentration of Bi is less than 7%, it becomes difficult to draw the alloy into a thin wire having a diameter of 350µmφ. In paragraph [0025] JP ‘724 teaches that an alloy containing 6% Bi could not be drawn into a wire with the desired diameter of 300 µmφ due to the improper ductility of the material. JP ‘724 also teaches that the amount of Sn (40 to 46%) provides significant ductility for drawing the alloy into a thin wire (JP ‘724 ¶ [0013]). There is no indication in JP ‘724 (nor has the Examiner made any allegations in this regard) that the concentration of Sn could be reduced and still provide similar results, such as the ability to draw the alloy into a thin wire (i.e., no reasonable expectation of success has been demonstrated).

The broad alloy of JP ‘724 contains 42-53% In. However, the preferred alloy composition of JP ‘724 contains 43-45% Sn and 7-9% Bi (leaving a remainder of 46-50% In), and the most preferred alloy of JP ‘724 contains 44.5% Sn, 7.4%Bi, and 48.1% In. Thus, preferred In concentrations are in the low to middle sections of the JP ‘724 range. That is, any

optimization of this range by JP '724 pointed away from modifying the alloy to increase the In concentration to 55-74% (above the recited range).

JP '724 thus teaches away from modification of the ternary alloy to decrease the Bi concentration or to increase the In concentration, which would be necessary to arrive at the present invention. Accordingly, JP '724 teaches away from the present invention, and Appellant has met the burden set forth in *Malagari* for establishing patentability despite the presence of an overlapping range.

4. AAPA Fails to Satisfy the Criteria for Establishing *Prima Facie* Obviousness

To properly satisfy the Examiner's burden in asserting a *prima facie* case of obviousness, based on a single reference, an Examiner must establish that the cited reference: (1) teaches or suggests each and every element of the claimed invention; (2) provides motivation to one of ordinary skill in the art to modify the reference to arrive at the claimed invention (it is NOT sufficient to say that the reference can be modified, without a teaching or suggestion in the reference as to the desirability of making the modification); and (3) provides one of ordinary skill in the art with a reasonable expectation of success. (MPEP § 2143)

a. No Motivation is Shown to Modify JP '724 for Any Desirable Purpose

The Examiner argues that a *prima facie* case of obviousness exists when the ranges in a claimed composition are close enough to those in the prior art that one skilled in the art would have expected them to have the same properties (middle of page 3 of final Office Action). In support of this argument, the Examiner states:

Thus, while routinely experimenting with AAPA alloy at the time of the invention, one versed in the relevant art would have noticed positive changes in physical properties of the resulting alloy, and would have arrived at the ranges as claimed in order to enhance breaking characteristics of the fuse (top of page 5 of final Office Action).

These statements by the Examiner are contradictory. On the one hand, the Examiner argues that one would have expected the claimed and prior art alloys to have the same properties

(middle of page 3 of final Office Action). On the other hand, the Examiner contends that when experimenting with the prior art alloy, one would have noticed positive changes in physical properties, which would result in one optimizing such concentrations to arrive at the claimed material. If the properties of alloys having close ranges were truly expected to be the same, there would have been no motivation to modify the alloys to change their properties.

In any event, the Examiner has not demonstrated where such a motivation appears in the reference. Specifically, the Examiner has not shown why one, routinely experimenting with the alloy of JP ‘724, would have noticed positive changes in physical properties, particularly if the experimenter were not looking for the same properties. The Examiner has not cited any section of JP ‘724 which discusses breaking characteristics of the fuse. That is, the Examiner has not demonstrated why, based on JP ‘724, one would have been looked for (noticed) or been motivated to modify the elemental concentrations (and in particular the concentration of In) to enhance breaking characteristics. In fact, the Examiner only appears to rely on Appellants’ description of JP ‘724 and does not refer to any specific sections of the reference at all (i.e., no motivation has been shown for any desired purpose).

Further, as set forth in Section VII.C.3. above, no reasonable expectation of success has been demonstrated.

Therefore, no teaching or suggestion to modify the reference or a reasonable expectation of success to make the modification, as required by MPEP § 2143, is found in JP ‘724.

b. There Can Be No Motivation to Modify to Obtain Negative Results

Further, since modification of the prior art ranges would have provided an alloy with inferior properties to the original alloy, it would not have been obvious to make such a modification. Rather, such a modification would have been counter-indicated. JP ‘724 teaches in paragraph [0004] that one of the requirements of a low-melting point fusible alloy is that the solid-liquid coexistence region be narrow. However, modification of the JP ‘724 alloy to arrive at the claimed alloy would have resulted in a widening of the solid-liquid coexistence region, an undesirable result based on the teaching of JP ‘724.

As explained above, the suggestion to modify the prior art reference must be found in the reference itself, and JP ‘724 actually teaches away from such a modification, since it would result in an undesirable (to JP ‘724) widening of the solid-liquid coexistence region. Further, MPEP § 2143.01 states that a proposed modification cannot render the prior art unsatisfactory for its intended purpose. Since modification of the JP ‘724 alloy to increase the In concentration would widen the solid-liquid coexistence region and thus make it unsatisfactory for the intended purpose of JP ‘724, this proposed modification would not support a *prima facie* case of obviousness.

c. JP ‘724 Teaches Away from the Proposed Modification

As stated in MPEP § 2144.03, a *prima facie* case of obviousness may be rebutted by showing that the art, in any material respect, teaches away from the claimed invention. As set forth in Section VII.C.3 above, JP ‘724 clearly teaches away from modification of the ternary alloy to increase the In concentration, which would be necessary to arrive at the present invention.

5. Criticality of In Concentration Has Been Shown and Rebutts any Prima Facie Case of Obviousness

The Examiner cites *Titanium Metals Corp. v. Banner* as teaching that a *prima facie* case of obviousness typically exists when the ranges of a composition are close enough to prior art ranges that one would have expected them to have the same properties. In *Titanium Metals*, the Court indeed held that the claimed alloy containing 0.3% Mo, 0.8% Ni, balance Ti was unpatentable over a reference which disclosed alloys containing 0.25% Mo, 0.75% Ni or 0.31% Mo, 0.94% Ni. The Court held that the compositions were in such close proportions that one would have expected them to have the same properties and no evidence to rebut the prima facie case of obviousness was produced.

Appellant submits that the claimed and prior art compositions are not “in close proportions” as they were in *Titanium Metals*. Rather, the claimed concentration of In (greater than 55% to 74%) differs by more than 2% compared with the concentration of In in JP ‘724 (42% to 53%). Further, the overall alloy compositions are not “in close proportion” as seen in the liquidus projection Diagram 1 in Appendix B.

MPEP § 2144.05 states that differences in concentrations will not support the patentability of subject matter encompassed by the prior art unless there is evidence indicating such concentration or temperature is critical. In the present case, the concentrations of the component elements are indeed critical to the resulting alloy. For example, as explained in the Request for Reconsideration filed May 17, 2005 (pages 3-5), the concentration of In in the present alloy, greater than 55% to 74%, is removed from the binary eutectic curve (47-50%) by at least 5% and as much as 27%, which makes the solid-liquid coexistence region as wide as 16°C. That is, the In range of the claimed invention, which the Examiner contends to be “close” to the In range of JP ‘724, is actually not close at all, because the In range of JP ‘724 places the alloy on the binary eutectic curve, while the In range of the claimed alloy places it far removed from the binary eutectic curve.

In the alloy of JP ‘724, the concentration of In is on or in the vicinity of the binary eutectic curve, and the resulting alloy has a narrow solid-liquid coexistence region. JP ‘724 even teaches in paragraph [0004] that it is a requirement of an alloy used as a fuse element of a thermal fuse that the solid-liquid coexistence region be narrow. However, when this region is narrow, undesirable results are observed. Namely, the alloy during energizing and temperature rise is instantly changed from solid to liquid, which causes an arc to be generated easily during operation. The resulting local and sudden temperature rise causes vaporization of the flux and raises the internal pressure or chars the flux. In addition, the molten alloy or the charred flux is intensely scattered. Due to these occurrences, physical destruction, such as crack generation due to local and sudden internal pressure rise, or reconnection between charred flux portions, easily occurs during operation. Insulation distance is thus shortened and dielectric breakdown results.

The wide solid-liquid coexistence region which is exhibited by the present invention will eliminate these undesirable characteristics. Thus, the concentration of In is indeed critical to the present invention, and does support patentability.

6. Unexpected Results Exhibited by Appellant’s Invention Rebuts Any *Prima Facie* Case of Obviousness

A *prima facie* case of obviousness may be overcome by demonstrating that the claimed invention exhibits unexpected results (MPEP § 716). JP ‘724 teaches in ¶ [0004] that it is

“required” and a “necessary condition” of the alloy that it has a narrow liquid-solid coexistence range so that the dispersion of the working temperature range of the thermal fuse will be small and the thermal fuse can work at a predetermined temperature. Based on JP ‘724, it would thus have been expected that an alloy having a wide solid-liquid coexistence region would have exhibited undesirable properties, that is, a wide dispersion of the working temperature ranges of the thermal fuse and an inability to work at a predetermined temperature.

To the contrary, while the alloys according to the present invention have a wide solid-liquid coexistence region, thermal fuses formed from such alloys have a narrow dispersion of operating temperature range of only $\pm 5^{\circ}\text{C}$ (Spec., ¶ [0026]) and work at predetermined temperatures. In fact, exemplary thermal fuses prepared according to the present invention (Examples 1-12 of Appellant’s Specification) exhibit dispersions of as low as $\pm 1^{\circ}\text{C}$, and no higher than $\pm 3^{\circ}\text{C}$. These properties would not have been expected based on JP ‘724 and are indicative of non-obviousness.

It would also not have been expected based on JP ‘724, which teaches away from a wide solid-liquid coexistence region, that thermal fuses prepared from alloys according to the invention will not exhibit the physical destruction, such as crack generation due to local and sudden internal pressure rise, or reconnection between charred flux portions, during operation. This destruction, which leads to dielectric breakdown, occurs in fuses prepared from alloys with a narrow solid-liquid coexistence region. Thus, the presence of unexpected properties has been demonstrated.

JP ‘724 also teaches (translation of JP ‘724 ¶ [0013]) that when the concentration of Bi in the ternary alloy is less than 7%, it becomes difficult to draw the alloy into a thin wire having a diameter of $350\text{ }\mu\text{m}\phi$, due to improper ductility. However, as described in Examples 1-9 of Appellant’s Specification, a variety of Sn-In-Bi alloys were prepared which contained less than 7% Bi, and all were found to exhibit good wire drawability. Specifically, in Example 1, an alloy containing 5% Bi was drawn into a wire having a diameter of $300\text{ }\mu\text{m}\phi$. Similar results were observed for alloys containing 1% Bi. The drawability of alloys containing less than 7% Bi would not have been expected based on JP ‘724. Thus, the presence of an unexpected property, which is evidence of non-obviousness, has been demonstrated.

VIII. CONCLUSION

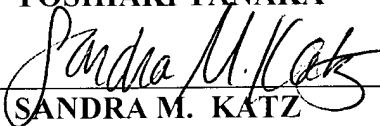
For the reasons set forth above, Appellant respectfully submits that the Examiner's rejection is improper and requests reversal of the Examiner's rejection.

Respectfully submitted,

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Attachments: Appendix A- Claims Appendix

Appendix B- Evidence Appendix (Liquidus Projection Diagrams 1 and 2)

APPENDIX A: CLAIMS APPENDIX

1. A material for a thermal fuse element wherein said material has an alloy composition in which Sn is larger than 25% and 44% or smaller, Bi is 1% or larger and smaller than 20%, and In is larger than 55% and 74% or smaller.
3. An alloy type thermal fuse wherein a material for a thermal fuse element of claim 1 is used as a fuse element.
5. An alloy type thermal fuse according to claim 3, wherein said fuse element contains inevitable impurities.
51. An alloy type thermal fuse according to claim 3, wherein said fuse element connected between a pair of lead conductors is sandwiched between insulating films.
53. An alloy type thermal fuse according to claim 5, wherein said fuse element connected between a pair of lead conductors is sandwiched between insulating films.
55. An alloy type thermal fuse according to claim 7, wherein said fuse element connected between a pair of lead conductors is sandwiched between insulating films.
57. An alloy type thermal fuse according to claim 9, wherein said fuse element connected between a pair of lead conductors is sandwiched between insulating films.

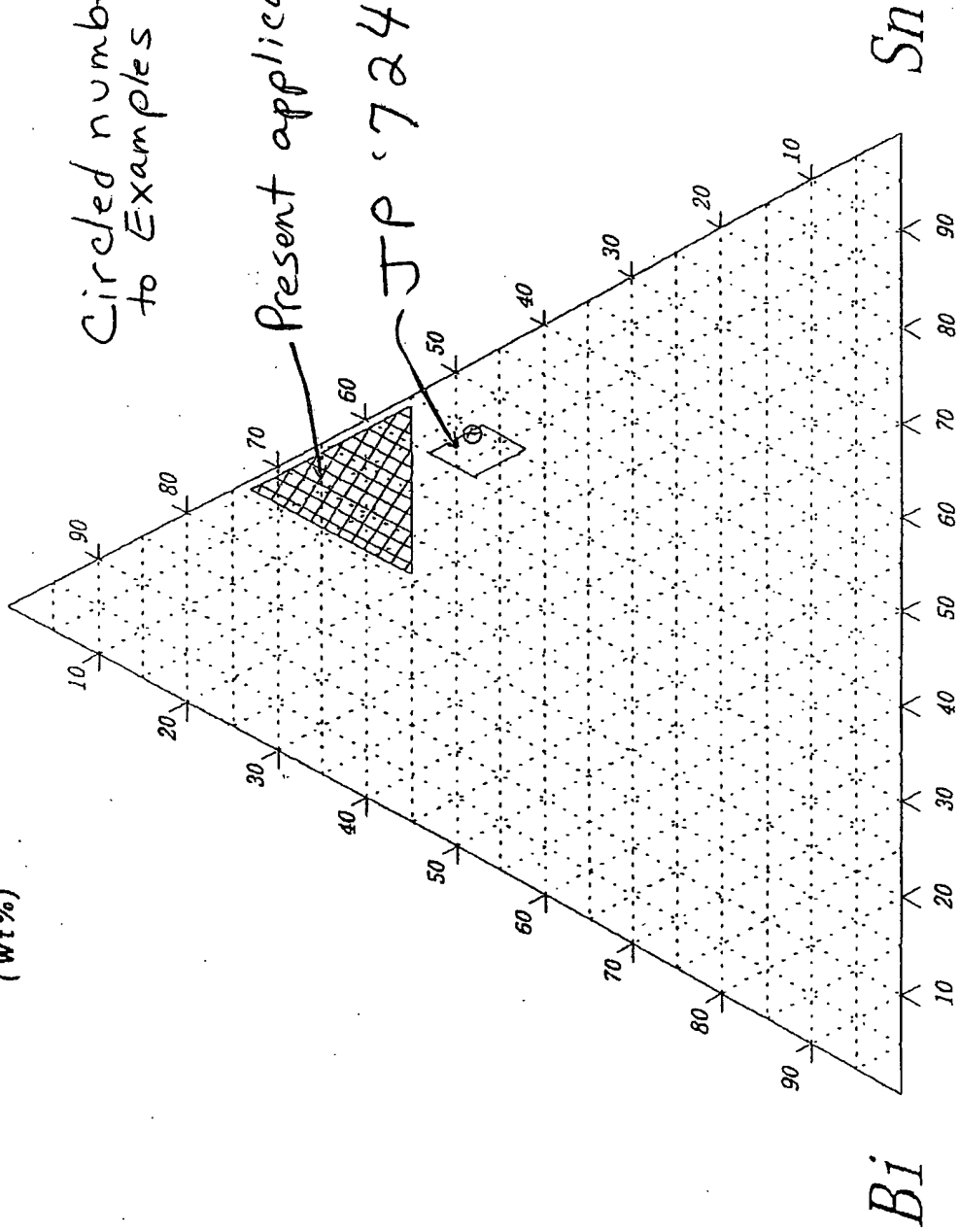
APPENDIX B: EVIDENCE APPENDIX

The liquidus projection diagrams (1) and (2) which follow were filed with the Request for Reconsideration filed on May 17, 2005, and were entered by the Examiner's reconsideration in the Office Action dated June 17, 2005 (Paper No. 0605) – see paragraph 1 at page 2 and paragraph 6 at page 4 of the Office Action.



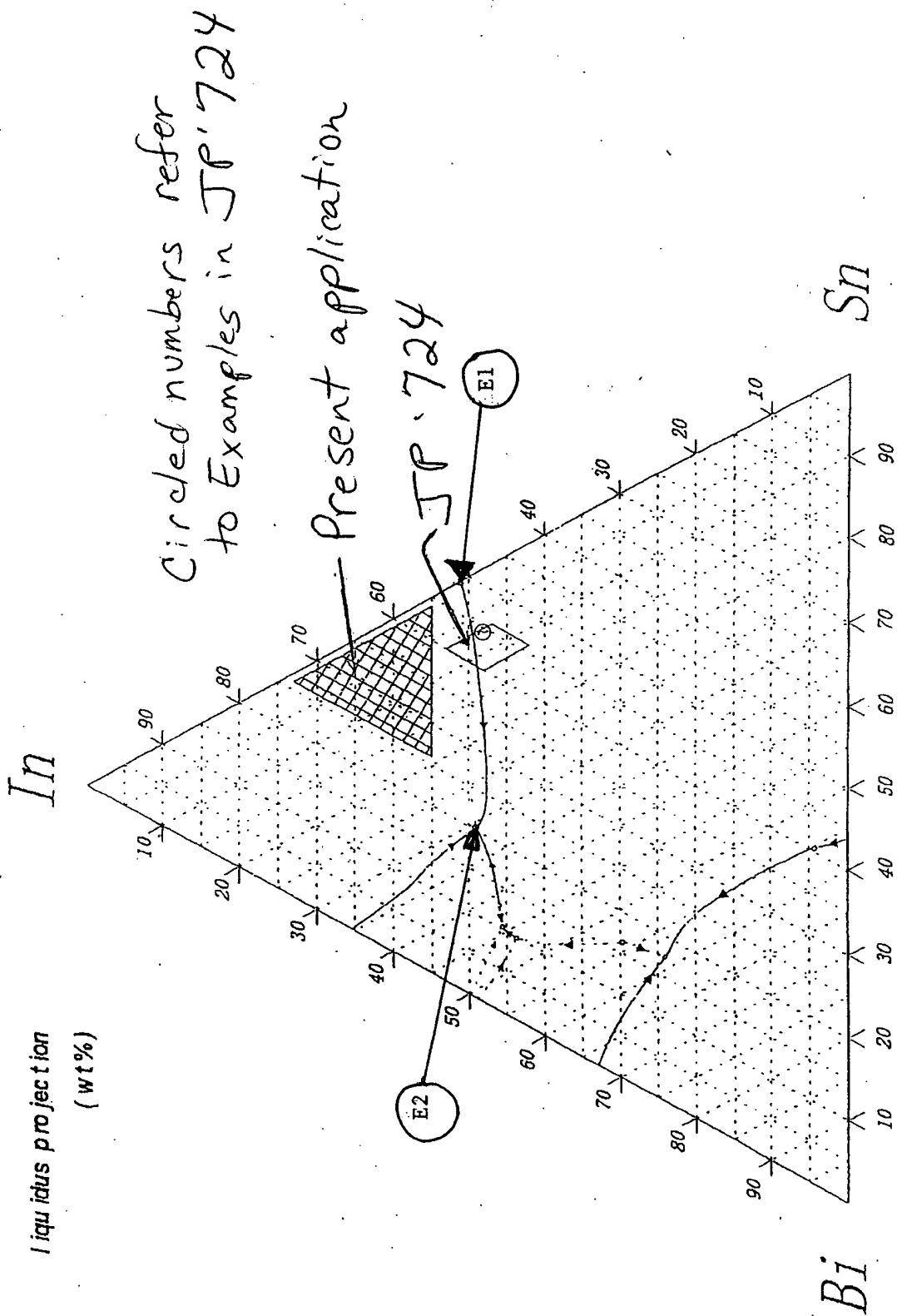
liquidus projection
(wt%)

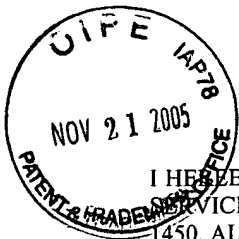
In



1

2





I HEREBY CERTIFY THAT THIS CORRESPONDENCE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS FIRST CLASS MAIL IN AN ENVELOPE ADDRESSED TO: COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450, ON THE DATE INDICATED BELOW.

BY:

Renee Conti

Date:

November 18, 2005

MAIL STOP APPEAL BRIEF

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:
Yoshiaki Tanaka

:

:

:

Conf. No.: 7843

:

Group Art Unit: 2835

:

Appln. No.: 10/656,580

:

Examiner: Anatoly Vortman

:

Filing Date: September 4, 2003

:

Attorney Docket No.: 10844-33US
(203061(C-3))

Title: Alloy Type Thermal Fuse and Material for a Thermal Fuse Element

SUBMISSION OF ENGLISH TRANSLATION OF PRIOR ART REFERENCE

. Submitted herewith is an English translation of JP 2001-266724, which is relied upon by the Examiner as a basis for the final rejection of the claims and discussed in the Appeal Brief being filed simultaneously. According to 37 C.F.R. § 41.33, evidence filed after the date of an appeal may be admitted if it is determined that the evidence overcomes all rejections under appeal and that a showing of good and sufficient reasons why the evidence is necessary and was not earlier presented has been made.

The translation is not really "evidence," but merely an aid to understanding the prior art relied upon. In the present situation, it was necessary for Appellant to obtain the enclosed English translation, which was not accomplished prior to the filing of an appeal. It is submitted that an English translation of the reference is helpful, if not necessary, for understanding the differences between the claimed invention and the prior art, and further that such an understanding will result in removal of the rejection. Accordingly, admission of the enclosed translation is respectfully requested.

Respectfully submitted,

YOSHIKI TANAKA

November 18, 2005

(Date)

By:

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Attachment: English translation of JP 2001-266724



English translation of JP2001-266724

(54) [Title of the Invention]

ALLOY TYPE THERMAL FUSE

(57) [Abstract]

[Purpose]

To provide an alloy type thermal fuse which has a working temperature in a range from 95°C to 105°C; satisfies a requirement for environmental preservation; can be drawn to a wire with a diameter so thin as to be about 300 $\mu\text{m}\phi$; satisfactorily suppresses self-heat generation, and is thus capable of working precisely.

[Solution to the Problems]

In the alloy type thermal fuse using a low melting point and fusible alloy as a fuse element, the alloy has a composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In.

[Scope of Claims]

[Claim 1]

An alloy type thermal fuse using a low melting point and fusible alloy as a fuse element, wherein the low melting point and fusible alloy has an alloy composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In.

[Claim 2]

An alloy type thermal fuse using a low melting point and fusible alloy as a fuse element, wherein 0.5 to 3.5 parts by weight of Ag is added to 100 parts by weight of the low melting point and fusible alloy having an alloy composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In.

[Detailed Description of the Invention]

[Industrial Field of the Invention]

[0001]

The present invention relates to an alloy type thermal fuse having a working temperature of 95°C to 105°C.

[Prior Art]

[0002]

An alloy type thermal fuse uses a low melting point and fusible alloy piece coated with a flux as a fuse element and has been used while being attached to an electric appliance to be protected.

[0003]

In this case, when the electric appliance generates heat

at an abnormal time, the low melting point and fusible alloy piece is liquefied by the generated heat and in coexistence of the flux, the fusible metal is made to be spherical owing to the surface tension and owing to the progress of spheroidization, the metal is disconnected to shut out electric communication to the electric appliance.

[0004]

One of necessary conditions required for the above-mentioned low melting point and fusible alloy is that the alloy has a narrow liquid-solid coexistence range between the solid phase line and the liquid phase line. That is, in general, with respect to an alloy, a liquid-solid coexistence range exists between the solid phase line and the liquid phase line and in this range, the solid phase granules are dispersed in the liquid phase and therefore, the alloy is also provided with a liquid phase-like property, so that the above-mentioned spheroidization disconnection may possibly be caused and accordingly, spheroidization disconnection of the low melting point and fusible alloy piece may possibly take place in a temperature range (defined as ΔT) belonging to the solid-liquid coexistence range before it reaches a liquid phase line temperature (the temperature is defined as T). In this connection, with respect to a thermal fuse using such a low melting point and fusible alloy piece, the thermal fuse has to be handled as it works in a temperature range from $(T - \Delta T)$ to T and accordingly,

as ΔT is smaller, namely, as the solid-liquid coexistence range is narrower, the dispersion of the working temperature range of the thermal fuse is small and the thermal fuse can work at the predetermined temperature. Consequently, the alloy to be used as the fuse element of the temperature fuse is required to have a narrow solid-liquid coexistence range.

[0005]

Further, along with the tendency of miniaturization of electronic and electric appliances in recent years, the thermal fuse has also been required to be compact. To satisfy the requirement of miniaturization, thin drawing processibility to an extent of 300 $\mu\text{m}\phi$ thinness is needed.

[0006]

[Problems to be Solved by the Invention]

Recently, along with the spread of mobile electronic appliances, demands for an alloy type thermal fuse having a working temperature in a range from 95°C to 105°C have been increased, and as the fuse element of the alloy type thermal fuse, it is required to have a solid-liquid coexistence range around 100°C with a width which is within an allowable range in terms of the operation of the thermal fuse, generally within 4°C. As an alloy satisfying the conditions have been employed a Bi-Pb-Sn alloy having an eutectic point of 96°C (Bi 52% by weight, Pb 32% by weight, and Sn 16% by weight) and a Bi-Sn-Cd alloy having an eutectic point of 103°C (Bi 54% by weight, Sn

16% by weight, and Cd 20% by weight). However, since these alloys contain Pb and Cd harmful in the ecology, it is required to improve the alloys in terms of environmental preservation.

[0007]

Conventionally, as a fuse element of an alloy type thermal fuse containing no harmful metal such as Pb or Cd have been known ternary alloys of Sn-In-Bi; however, the ductility is considerably high as compared with the alloy strength and therefore, it is very difficult to process the alloys to wires as thin as 300 $\mu\text{m}\phi$ although it is possible to carry out machining to obtain fuse elements with a wire diameter of 500 $\mu\text{m}\phi$ or thicker, which is used for conventional alloy type thermal fuses.

[0008]

In view of the above-mentioned state of the art, the inventor has made investigations to develop an alloy type thermal fuse using an In-Sn-Bi ternary alloy for its fuse element which has a working temperature in a range from 95°C to 105°C and a diameter made so thin as to be about 300 $\mu\text{m}\phi$, and which suppresses self-heat generation, and is thus capable of working precisely, and accordingly has found that the aims can be achieved by employing an alloy composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In.

[0009]

Based on the finding, the invention aims to provide an alloy type thermal fuse which has a working temperature in a

range from 95°C to 105°C, satisfies the demand for environmental preservation, can make the fuse element diameter as thin as about 300 $\mu\text{m}\phi$, and can precisely work with suppressed self-heat generation.

[0010]

[Means for Solving the Problems]

An alloy type thermal fuse according to claim 1 of the present invention is a thermal fuse using a low melting point and fusible alloy as a fuse element and characterized in that the low melting point and fusible alloy has an alloy composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In. An alloy type thermal fuse according to claim 2 of the present invention is a thermal fuse using a low melting point and fusible alloy as a fuse element and characterized in that 0.5 to 3.5 parts by weight of Ag is added to 100 parts by weight of the low melting point and fusible alloy has an alloy composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In. Addition of Ag can lower the specific resistance and narrow the solid-liquid coexistence range with scarce change of the working temperature so as to further suppress the dispersion of the working temperature.

[0011]

[Embodiment of the Invention]

With respect to an alloy type thermal fuse according to the present invention, a round wire with an outer diameter of

200 $\mu\text{m}\phi$ to 500 $\mu\text{m}\phi$, preferably 250 $\mu\text{m}\phi$ to 350 $\mu\text{m}\phi$, or a flat wire with the same cross-sectional surface area as the round wire can be used as a fuse element.

[0012]

An alloy for the fuse element has a composition containing Sn 40 to 46% by weight, Bi 7 to 12% by weight, and balance In, preferably Sn 43 to 45% by weight, Bi 7 to 9% by weight, and balance In, and a standardized composition containing Sn 44.5% by weight, Bi 7.4% by weight, and In 48.1% by weight and has a liquid phase line temperature of 102°C and a solid-liquid coexistence range width of 4°C.

[0013]

In and Sn provide the ductility sufficient for drawing to obtain an extra thin wire and Bi adjusts a melting point to be around 100°C within a solid-liquid coexistence range of 98°C to 102°C. If Bi is less than 7% by weight, the strength is so insufficient as to make it difficult to draw the alloy to a wire as extra thin as 350 $\mu\text{m}\phi$. If it exceeds 12% by weight, the alloy becomes brittle to make it difficult to draw the alloy to the similar wire difficult. Since temperature difference about 2°C is caused owing to heat resistance between the fuse element of the thermal fuse and an appliance, the working temperature of the thermal fuse employing the standardized composition is in a range from 100°C to 104°C. The resistivity of the fuse element is about 20 $\mu\Omega\cdot\text{cm}$.

[0014]

Addition of Ag 0.5 to 3.5 part by weight to the above-mentioned alloy composition 100 part by weight can make the resistivity lower than that. For example, when Ag 3.5 part by weight is added, the resistivity is lowered by about 10%.

[0015]

The fuse element of the thermal fuse according to the present invention is produced by drawing an alloy mother material to a wire and as having a round cross-sectional shape or being press-machined to be a flat, the obtained wire can be used.

[0016]

Fig. 1 shows a tape-type alloy type thermal fuse according to the present invention in which strip-type lead conductors 1, 1 with a thickness of 100 to 200 μm are fixed on a plastic base film 41 with a thickness of 100 to 300 μm with an adhesive or thermal fusion; a fuse element 2 with a wire diameter of 250 $\mu\text{m}\phi$ to 500 $\mu\text{m}\phi$ is connected between the strip-type lead conductors, a flux 3 is applied to the fuse element 2; and the flux-coated fuse element is fixed by a plastic cover film 41 with a thickness of 100 to 300 μm with an adhesive or thermal fusion to achieve sealing.

[0017]

The alloy type thermal fuse according to the present invention may be in form of a cylindrical case type, a cased radial type, a substrate type, a resin-molded radial type. Fig.

2 shows a cylindrical case type in which a low melting point and fusible alloy piece 2 is connected between a pair of lead wires 1, 1; a flux 3 is applied to the low melting point and fusible alloy piece 2; the flux-coated low melting point and fusible alloy piece is inserted into an insulating cylinder 4 having heat resistance and good heat conductivity, e.g. a ceramic cylinder; and gaps between both ends of the insulating cylinder 4 and the lead wires 1, 1 are sealed with a room temperature-curable adhesive, e.g. an epoxy resin.

[0018]

Fig. 3 shows a cased radial type in which a fuse element 2 is joined between the tip end parts of parallel lead conductors 1, 1 by welding; a flux 3 is applied to the fuse element 2; the flux-coated fuse element is surrounded with a one end-opened insulating case 4, e.g. a ceramic case; and the opening of the insulating case 4 is sealed with a sealing material 5 such as an epoxy resin.

[0019]

Fig. 4 shows a substrate type in which a pair of membrane electrodes 1, 1 are formed by printing and baking a conductive paste (e.g. a silver paste) on an insulating substrate 4, e.g. a ceramic substrate; lead conductors 11 are connected to the electrodes 1 by welding or the like; a fuse element 2 is joined between the electrodes 1 by welding; a flux 3 is applied to the fuse element 2; and the flux-coated fuse element is sealed with

a sealing material 4, e.g. an epoxy resin.

[0020]

Fig. 5 shows a resin-molded radial type in which a fuse element 2 is welded to tip ends of parallel lead conductors 1, 1 through welding; a flux 3 is applied to the fuse element 2; and the flux-coated fuse element is molded with a resin 5 by dipping in a resin liquid.

[0021]

Further, the fuse may be an electricity application type heating element-bearing fuse, for example, a type of a resistance-bearing substrate type fuse in which a resistor (a membrane resistor) is attached to an insulating substrate of a substrate type alloy thermal fuse and the resistor is heated by electricity application when an appliance is abnormal and the low melting point and fusible alloy piece is melted and disconnected with the generated heat.

[0022]

In general, those having a melting point lower than that of the fuse element are used as the above-mentioned flux and for example those containing rosin 60 to 90 part by weight, stearic acid 10 to 40 part by weight, and an active agent 0 to 3 part by weight may be used. In this case, the rosin may include natural rosin, modified rosin (e.g. hydrogenated rosin, disproportioned rosin, and polymerized rosin) and refined rosin of them. The active agent may be diethylamine hydrochloride and diethylamine

hydrobromide.

[0023]

[Example]

(Example 1)

A mother material of an alloy composition containing In 48.1% by weight, Sn 44.5% by weight, and Bi 7.4% by weight was drawn to be a wire with a diameter of 300 $\mu\text{m}\phi$. The reduction ratio per one die was set to be 6.5% and drawing speed was set to be 45 m/min and no disconnection took place. The resistance of the obtained wire was measured to find that it was 23 $\mu\Omega\cdot\text{cm}$. The wire was cut into 4 mm length to obtain a fuse element and a tape type thermal fuse was produced, using the fuse element. As a flux, a composition containing a rosin 80 part by weight, stearic acid 20 part by weight, and diethylamine hydrobromide 1 part by weight was used and a 200 μm -thick polyethylene terephthalate film was used for the plastic base film and the plastic cover film.

[0024]

Fifty pieces of the product obtained in the Example were immersed in an oil bath and heated at a heating speed of 1°C/min while 0.1 A electricity was applied to measure the oil temperature at the time when the electricity application was cut owing to melt disconnection of the product and the oil temperature was found 102°C \pm 1°C. If the alloy composition was within the above-mentioned range, the working temperature could be kept

within $\pm 5^{\circ}\text{C}$ around 100°C .

[0025]

In the case the content of Bi was changed to be in a range of less than 6% by weight and 13% by weight or more and drawing the alloy to be a wire with a diameter of $300\text{ }\mu\text{m}\phi$ was tried, however it was difficult owing to excess ductility or insufficient ductility.

[0026]

(Example 2)

A mother material of an alloy composition containing In 46.5% by weight, Sn 43.0% by weight, Bi 7.1% by weight, and Ag 3.4% by weight was drawn to be a wire with a diameter of $300\text{ }\mu\text{m}\phi$. The reduction ratio per one die was set to be 6.5% and drawing speed was set to be 45 m/min and no disconnection took place. The resistance of the obtained wire was measured to find that it was $20\text{ }\mu\Omega\cdot\text{cm}$. The wire was cut into 4 mm length to obtain a fuse element and a tape type thermal fuse similar to that of Example 1 was produced, using the fuse element.

[0027]

Fifty pieces of the product obtained in the Example were immersed in an oil bath and heated at a heating speed of $1^{\circ}\text{C}/\text{min}$ while 0.1 A electricity was applied to measure the oil temperature at the time when the electricity application was cut owing to melt disconnection of the product and the oil temperature was found $101^{\circ}\text{C} \pm 1^{\circ}\text{C}$. If the alloy composition was within the

above-mentioned range, the working temperature could be kept within $\pm 4^{\circ}\text{C}$ around 100°C .

[0028]

[Effects of the Invention]

According to the present invention, a fuse element with a wire as extra thin as $300\text{ }\mu\text{m}\phi$ can be produced by drawing a mother material of a low melting point and fusible Sn-Bi-In type alloy, which does not cause adverse effects on ecology, at a high efficiency, and by means of using the fuse element, an alloy type thermal fuse having a working temperature of 95°C to 105°C and capable of surely preventing error of operation owing to self-heat generation can be obtained.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a drawing showing one example of the alloy type thermal fuse of the present invention.

[Fig. 2] Fig. 2 is a drawing showing another example of the alloy type thermal fuse of the present invention.

[Fig. 3] Fig. 3 is a drawing showing also another example of the alloy type thermal fuse of the present invention.

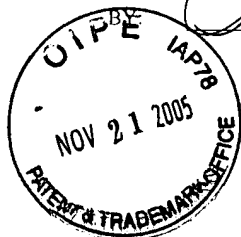
[Fig. 4] Fig. 4 is a drawing showing also another example of the alloy type thermal fuse of the present invention.

[Fig. 5] Fig. 5 is a drawing showing also another example of the alloy type thermal fuse of the present invention.

[Explanation of Symbol]

2 fuse element

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Renée Conti

Date: November 18, 2005

MAIL STOP APPEAL BRIEF - PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:
Yoshiaki Tanaka

Conf. No.: 7843

: Group Art Unit: 2835

Appln. No.: 10/656,580

: Examiner: Anatoly Vortman

Filing Date: September 4, 2003

: Attorney Docket No.: 10844-33US
: (203061(C-3))

Title: Alloy Type Thermal Fuse and Material for a Thermal Fuse Element

APPEAL BRIEF TRANSMITTAL LETTER

Enclosed are the following:

<input checked="" type="checkbox"/>	Appellant's Brief Under 37 C.F.R. § 1.192;
<input type="checkbox"/>	A Petition for Extension of time with requisite fee;
<input checked="" type="checkbox"/>	A check in the amount of \$250.00 to cover the filing fee.
<input checked="" type="checkbox"/>	The Commissioner is hereby authorized to charge Deposit Account No. 50-1017 (Billing No. 210844.0033) as noted below. An additional copy is enclosed.
<input type="checkbox"/>	<input type="checkbox"/> Appellant's Brief fee in the amount of _____.
<input type="checkbox"/>	<input checked="" type="checkbox"/> Any deficiencies or overpayments in the above-calculated fee.
<input checked="" type="checkbox"/>	Translation of JP 2001-266724

Respectfully submitted,

YOSHIAKI TANAKA

November 18, 2005
(Date)

By:

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